NON-PUBLIC?: N
ACCESSION #: 9003200230
LICENSEE EVENT REPORT (LER)

FACILITY NAME: SAN ONOFRE NUCLEAR GENERATING STATION PAGE: 1 OF 07
UNIT 1

DOCKET NUMBER: 05000206

TITLE: REACTOR TRIP ON LOW FLOW DUE TO INSTRUMENT CABLE DEGRADATION
EVENT DATE: 08/03/89 LER #: 89-021-01 REPORT DATE: 03-09-90

OTHER FACILITIES INVOLVED: NONE DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 091

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: H.E. Morgan, Station Manager TELEPHONE: (714) 368-6241

COMPONENT FAILURE DESCRIPTION:
CAUSE: SYSTEM: COMPONENT: MANUFACTURER:
REPORTABLE NPRDS:

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT:

At 1800 on 8/3/89, with Unit 1 at 91% power, a reactor trip occurred due to actuation of the Reactor Protection System (RPS) on low Reactor Coolant System (RCS) flow in one loop. All systems responded normally to the trip and the operators (utility, licensed) stabilized the plant in Mode 3. The RPS operated in accordance with design, with no malfunctions noted.

The brief low RCS flow signal occurred in Loop C and was caused by a loss of insulation resistance of the flow transmitter cable. The loss of insulation resistance resulted from time-temperature-radiation exposure degradation of the polyethylene insulation which has occurred since installation of the cable during original construction (i.e., prior to 1968).

As corrective action, the cable was replaced and the RCS Loop C flow instrument was verified to be operating properly. The remaining two RCS loop flow instrumentation cables were tested and were found to be satisfactory. The RCS loop flow instrumentation cabling and the remaining cabling having the same insulation, which remain in service in important-to-safety applications, are not required to be Environmentally Qualified (EQ). The remaining cables having similiar insulation will be periodically tested for insulation degradation. A sample of these cables will be removed from service during the next refueling outage and replaced. The cables in the sample will be examined for indication of insulation degradation. Appropriate corrective actions will be developed based on the examination results.

END OF ABSTRACT

Plant: San Onofre Nuclear Generating Station
Unit: One
Reactor Vendor: Westinghouse
Event Date: 8-03-89
Time: 1800

A. CONDITIONS AT TIME OF THE EVENT:

Mode: 1, Power Operation

B. BACKGROUND INFORMATION:

The Reactor Protection System (RPS)JC! provides reactor trip functions to protect the core against Departure from Nucleate Boiling (DNB) and the Reactor Coolant System (RCS)AB! against overpressurization. There are three RCS loops (A, B, and C), each containing a hot leg, flow measuring elbow, steam generator SG!, Reactor Coolant Pump (RCP)(P) (with associated circuit breaker BKR!), and cold leg. The RPS generates a reactor trip on single loop loss of flow when flow in any loop is less than 85% of full flow, or when a RCP breaker opens. This trip is active when reactor power is above 49% of full power.

A RCS flow measuring elbow directs RCS flow from the horizontal hot
leg up 60 degrees into the steam generator. The change in direction of the flow creates a higher pressure against the bottom of the elbow and a lower pressure at the top of the elbow. Pressure

sensing lines run from taps (at the top and bottom of the RCS Loop C elbow) to a differential pressure measuring transmitter FT!. The transmitters sense a pressure differential of between 0 and 198 inches of water and convert this measurement to a 10 to 50 milliamperes Direct Current (maDC) signal, respectively. The pressure sensing lines are approximately 6 and 10 feet long and consist primarily of stainless steel tubing. The signal is conducted from the transmitter by a 2-conductor control cable CBL1!. The two polyethylene insulated copper conductors are twisted together with a copper ground conductor and are surrounded by a copper braided shield which is covered with a black colored polyethylene jacket. The insulation on one of the conductors was colored black and the other was colored white. All conducting elements of the cable are tinned. The cable runs approximately 10 feet from the transmitter inside a conduit CND! to a cable tray TY! and then from the tray through a containment penetration PEN! to the control room area. The conduit protects the cable from the harsh industrial surroundings near the transmitter. The conduit is open at the tray. In the control room area the signal is processed to provide the operator with indication of 0 to 100% full flow and a low loop flow alarm.

In response to Generic Letter 87-12, "Loss of Residual Heat Removal While the RCS is Partially Filled", modifications were implemented in mid-1988 to provide control room indication of RCS level during refueling and certain maintenance activities. As a result, design changes were

initiated to provide the required instrumentation; however, completion is not expected until mid-1990. In the interim, when control room refueling level indication is needed, a temporary modification is implemented which consists of installing a level sensing transmitter LT! using RCS Loop C flow instrument pressure sensing lines and cable.

C. DESCRIPTION OF THE EVENT:

1. Event:

At 1800 on 8/3/89, with Unit 1 at 91% power, a reactor trip occurred due to actuation of the RPS on low RCS flow in one loop. All systems responded normally to the trip and the operators (utility, licensed) stabilized the plant in Mode 3.

2. Inoperable Structures, Systems or Components that Contributed to the Event:

None.

3. Sequence of Events:

TIME ACTION

1800 Reactor trip on low RCS loop flow.

1809 RCPs were restarted and operated normally. Loop flow indications were normal.

1815 Operators complete trip response actions.

1851 Plant systems aligned for Hot Standby.

4. Method of Discovery:

Control room alarms and indications alerted the operators of the reactor trip.

5. Personnel Actions and Analysis of Actions:

The operators responded properly to the reactor trip and stabilized plant conditions utilizing trip procedures.

The operators also responded properly by restarting the RCPs and subsequently verifying that RCS flow indications were normal.

6. Safety System Responses:

The RPS operated in accordance with design, with no malfunctions noted.

D. CAUSE OF THE EVENT:

1. Immediate Cause:

The RPS initiated a reactor trip on low RCS flow as recorded in the Event Recorder and "first out" alarm status. "First out" alarm status refers to the first alarm recorded in

chronological order of occurrence. The Event Recorder showed that the trip condition existed briefly, indicative of a spike of the loss of flow signal. When the RCPs were restarted per procedure, all three loop flow indicators responded normally, indicating 100% flow. Since the response was normal and the individual loop flows are not recorded (which would have provided flow values prior to the trip) a determination of which RCS loop(s) initiated the loss of flow signal could not be made at the time of the event. Extensive trouble-shooting was implemented to determine the cause of the low flow trip. The following items were included in the investigation:

a) The RPS and flow instrument power supplies were checked and found to be functioning properly with no output spiking.

b) The RCP electrical supply breakers were found to be normal.

c) All three RCS loop flow instruments were function and calibration checked. All three were found to be functioning within specification.

d) All three flow transmitters were verified to have correct "span". All three transmitters were found to have negative "zero" shift (considered to be non-consequential) with Loop C having the largest (0.85 maDC). Negative "zero" shift causes the actual flow to be measured at a lower more conservative value, closer to the low flow set point. The transmitter sensing lines were verified to be filled with reactor coolant.

e) All three instrument circuits were tested for grounds using an Electrical Characterization And Diagnostic (ECAD) system. RCS Loops A and B flow instrument circuits were found to be satisfactory. RCS Loop C flow instrument circuit was found to have significant loss of insulation resistance to ground. Follow-up ECAD testing determined the insulation resistance loss to be located in the approximately 10 feet of cable enclosed in conduit between the flow transmitter and cable tray. The conduit was opened and the cable withdrawn. Initial visual inspection of the cable revealed a moist substance on the cable and no physical defects were noted. The cable was replaced and the instrument thoroughly checked. The instrument was found to be operating normally after the repair. In

addition all RCS loop flow instruments have been monitored and found to be operating satisfactorily since the event.

2. Intermediate Cause:

An examination of the 10 foot segment of Loop "C" cable having the apparent moist substance by a testing laboratory found cracks in the polyethylene cable insulation of both conductors. The white insulation appeared to be more brittle than the black insulation. The cracks in the cable insulation were localized to the mid-section of the 10 foot segment of the cable. Energy Dispersive Spectroscopy (EDS) of material found in the signal cable insulation cracks determined the material to be primarily copper and carbon with traces of aluminum, chlorine and calcium. In the presence of moisture, the conductive corrosion products in the insulation cracks could result in current leakage between the two signal conductors and/or the cable shielding. Such an electrical connection between the two conductors and/or the cable shielding, combined with the above described negative "zero" offset, could have caused the low reactor coolant flow reactor trip. The RCS flow instruments are not required to function after the reactor is tripped. Therefore, they have not been designed to endure a harsh, post-accident, environment.

3. Root Cause:

The testing lab results indicate that the polyethylene insulation had become brittle due to oxidation. The cause of the insulation oxidation can not be determined with any certainty; it is, however, believed to result from time-temperature-radiation exposure since the cable was installed during initial construction of the plant (i.e., prior to 1968). Since installation, the cable has been exposed to low levels of radiation and temperatures ranging from 90 to 105 degrees F during plant operation.

The cause of the downward spike in the low RCS flow signal which caused the reactor trip was a loss of insulation resistance of the flow transmitter cable combined with moisture and conducting contaminants in the insulation cracks.

The moisture most likely entered the conduit during the installation of a temporary RCS level transmitter (during the

recently completed Cycle 10 refueling outage). During this time, the conduit and cable are exposed.

E. CORRECTIVE ACTIONS:

1. Corrective Actions Taken:

a) The cable with indicated loss of insulation to ground was replaced and the RCS Loop C flow instrument was verified to be operating properly. As described in Part D.1.e) above, the

remaining two RCS loop flow instrumentation cables were ECAD tested and were found to be satisfactory.

b) The procedure by which the temporary efueling water level indicator is installed and removed has been modified to include provisions which ensure that water cannot enter the conduit during periods in which the conduit is open.

c) The cable was sent to an independent offsite laboratory to determine the mechanism for the insulation degradation.

2. Planned Corrective Actions:

a) A limited number of similar cables remain in service at Unit 1 in important to safety applications. None of these applications (including RCS loop flow instrumentation) require that the cables be Environmentally Qualified. A sample of these cables will be removed from service and replaced during the next refueling outage which is scheduled to begin in June 1990. The cables in this sample will be examined for indication of insulation degradation. Appropriate corrective actions will be developed based on the examination results.

b) The previously planned permanent refueling level instrument will be provided. The instrument will have adequate protection from foreign substances and will be installed during the next refueling outage which begins in June 1990.

c) The RCS Loop flow instruments' cables and other similiarly

insulated cables will be periodically tested using the ECAD or similar system to assess insulation integrity. This action was previously planned. However, the test implementation schedule was such that the cables had not yet been initially tested.

F. SAFETY SIGNIFICANCE OF THE EVENT:

There was no safety significance associated with the reactor trip since all safety and protective systems operated in accordance with their design.

G. ADDITIONAL INFORMATION:

1. Component Failure Information:

The cable is believed to have been manufactured by company known only as "Rome". The cable was probably manufactured in the early to middle 1960's and was installed as part of the original plant construction (i.e., prior to 1968). No records have been identified which provide information about the manufacturer or the cable.

2. Previous LERs for Similar Events:

LER 87-008

On 6/2/87, with Unit 1 in Mode 5, meggering of Control Rod Drive Mechanism (CRDM) coil circuits revealed low insulation resistance in several circuits. The source of the low resistance was found to be in the containment penetration electrical "pigtails". In several cases the insulation was found to be damaged, and in the balance of cases the insulation was damaged and the conductor corroded. As corrective action, the damaged penetration electrical "pigtails" were repaired and appropriate administrative controls implemented which would prevent damage by work activities. Since these corrective actions were applicable to containment penetrations, they could not have prevented cable damage near the RCS Loop C flow transmitter.

3. Results of NPRDS Search:

Not applicable.

4. Procedure Enhancements:

During the root cause analysis of this event, it was determined that a brief loss of flow signal could have been generated by the expulsion of an air bubble from the flow instrument tubing. However, based upon an interview with the technician who removed the level transmitter and placed the flow transmitter in service prior to the event, and verification during the post-trip trouble-shooting, it was determined that the sensing lines were properly filled and vented. During this review, it was identified that the procedure for the installation and removal of the refueling level instrument did not specifically detail the steps necessary to fill and vent the RCS Loop C flow sensing lines. In order to correct this potential problem related to the event, procedural enhancements have been made to assure proper filling and venting of the flow transmitter.

ATTACHMENT 1 TO 9003200230 PAGE 1 OF 1

Southern California Edison Company

SAN ONOFRE NUCLEAR GENERATING STATION
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STATION MANAGER March 9, 1990 (714) 368-6241

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Subject: Docket No. 50-206
Supplemental Report
Licensee Event Report No. 89-021, Revision 1
San Onofre Nuclear Generating Station, Unit 1

Reference: Letter, H.E. Morgan (SCE) to USNRC Document Control Desk, dated September 5, 1989

The referenced letter provided Licensee Event Report (LER) No. 89-021, for an occurrence involving an automatic actuation of the reactor protection system. The enclosed supplemental LER provides additional information concerning causes and corrective action. Neither the health and safety of plant personnel or the public was affected by this

occurrence.

If you require any additional information, please so advise.

Sincerely,

Enclosure: LER No. 89-021, Rev. 1

cc: C.W. Caldwell (USNRC Senior Resident Inspector, Units 1, 2 and 3)
J.B. Martin (Regional Administrator, USNRC Region V)
Institute of Nuclear Power Operations (INPO)

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